Hoechst Celanese

Chemical Group
Hoechst Celanese Corporation
Bay City Plant
PO Box 509
Highway 3057
Bay City, TX 77404-0509

November 27, 1995
IOC-077-95

FEDERAL EXPRESS MAIL

Mr. Phil Dellinger
Underground Injection Control Program
Environmental Protection Agency
1445 Ross Avenue, Suite #1200
Dallas, Texas 75202-2733

Subject: WDW-32 (PLANT WELL NUMBER 3)
1995 MECHANICAL INTEGRITY TESTING AND
BOTTOM HOLE PRESSURE/FALLOFF SURVEY REPORT
HOECHST CELANESE CHEMICAL GROUP, INC.
BAY CITY PLANT, BAY CITY, TEXAS

Dear Mr. Dellinger:

Please find enclosed herewith a copy of a letter from Mr. Wesley W. Smith, ECO Solutions, Inc., dated November 13, 1995, with the referenced 1995 Mechanical Integrity Testing and Bottom Hole Pressure/Falloff Survey Report for WDW-32.

This report is provided for your information and file. Two copies of the report were hand delivered to the Texas Natural Resource Conservation Commission Underground Injection Control personnel on Tuesday, November 14, 1995.

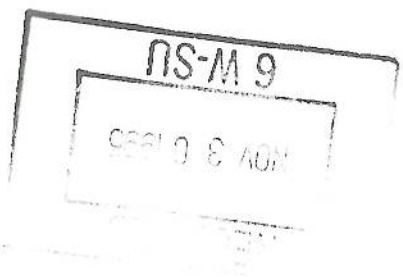
I can be contacted by telephone at 409/241-4197 if you have questions.

Very truly yours,

I. O. Coleman, Jr.
Staff Environmental Chemist

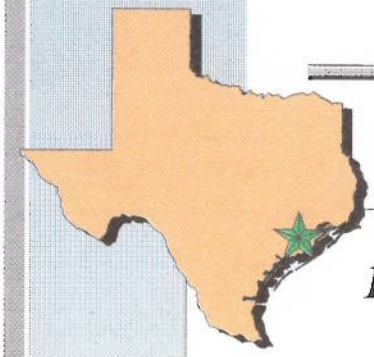
Hoechst

cc: Mr. Ben Knape, Head
Underground Injection Control Unit
Texas Natural Resource Conservation Commission
P. O. Box 13087
12100 Park 35 Circle
Austin, Texas 78711-3087



SOLUTIONS, INC.

Final Report



Hoechst Celanese Chemical Group, Inc.
Bay City, Texas
MIT/Fall-off Report
Injection Well WDW-32 (Well No. 3)
October 24 - 26, 1995

ECO Solutions, Inc.
9800 Richmond Avenue
Suite 320
Houston, Texas 77042
(713) 780-1955
FAX (713) 780-0870

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APPENDICES

1.0 INTRODUCTION AND EXECUTIVE SUMMARY

1.1 INTRODUCTION

Hoechst Celanese Chemical Group, Inc. (HCCG) contracted ECO Solutions, Inc. (ECO) to perform the annual mechanical integrity testing on their Class I nonhazardous injection well, WDW-32 (Well No. 3), located at their Bay City facility. A schematic drawing of WDW-32 is included as Figure 1. The attached report details the data and test results associated with the mechanical integrity testing.

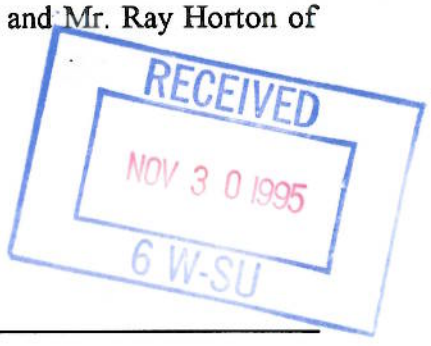
The following provides an overview of the key elements of the testing on WDW-32 (Well No. 3).

- An Annulus Pressure Test (APT) was conducted to satisfy the annual mechanical integrity test (MIT) requirements of the Texas Natural Resource Conservation Commission's (TNRCC), Underground Injection Control (UIC) Program.
- A Radioactive Tracer (RAT) survey was conducted to satisfy the annual MIT requirements of the TNRCC.
- Bottom Hole Pressure (BHP) falloff testing was conducted to satisfy the annual ambient monitoring requirements of the U.S. Environmental Protection Agency (EPA) and the TNRCC

HCCG personnel contacted the TNRCC personnel to inform them of the MIT schedule on WDW-32 and whether a field inspector would be present. TNRCC personnel informed HCCG that no field inspector would be present for this particular MIT.

The APT on WDW-32 (Well No.3) was conducted on Thursday, October 26, 1995, and was witnessed by Mr. Wesley Smith of ECO and Mr. Ray Horton of HCCG. The RAT was conducted on Thursday, October 26, 1995, and was witnessed by Mr. Wesley Smith of ECO and Mr. Ray Horton of HCCG.

The BHP/falloff test was conducted on Tuesday, October 24, 1995 through Thursday, October 26, 1995 and was witnessed by Mr. Wes Smith of ECO and Mr. Ray Horton of HCCG.



1.2 EXECUTIVE SUMMARY

Based on the successful results of the MIT conducted on October 26, 1995 on WDW-32, HCCG is able to return WDW-32 to injection service if required. Also, based on a decision by HCCG's Bay City management WDW-32 was brined in on October 27, 1995 using 150 barrels (42 gallons/barrel) of 10 pound per gallon (ppg) brine and left shut-in until closure operations are commenced. A summary of the results of the MIT and BHP/Falloff survey are as follows:

Radioactive Tracer Survey

The analysis of the RAT survey performed on October 26, 1995 demonstrated that no upward fluid movement from the injection interval is occurring. Additionally, this determination can be made as a result of (1) the favorable comparison of the before and after base gamma ray surveys, (2) the two multiple pass tracer surveys and the two stationary surveys conducted 20' above the packer path. All four tests showed no evidence of upward migration. This interpretation was supported by an independent evaluation provided by Atlas Wireline Services (Atlas) and is included in Appendix A together with the RAT log.

Annulus Pressure Test

A demonstration of internal mechanical integrity was supported by an APT conducted on October 26, 1995. The annulus was pressurized to a maximum of 1109 pounds per square inch gauge (psig). The APT was monitored for eighty minutes. During the final 30 minutes the pressure loss was measured from 1102 to 1101 psig, or 1 pound per square inch (psi) (0.1%), which is well within the 5% pressure loss criteria set by the TNRCC. The APT plot is included in Appendix B.

Bottom Hole Pressure Falloff Survey

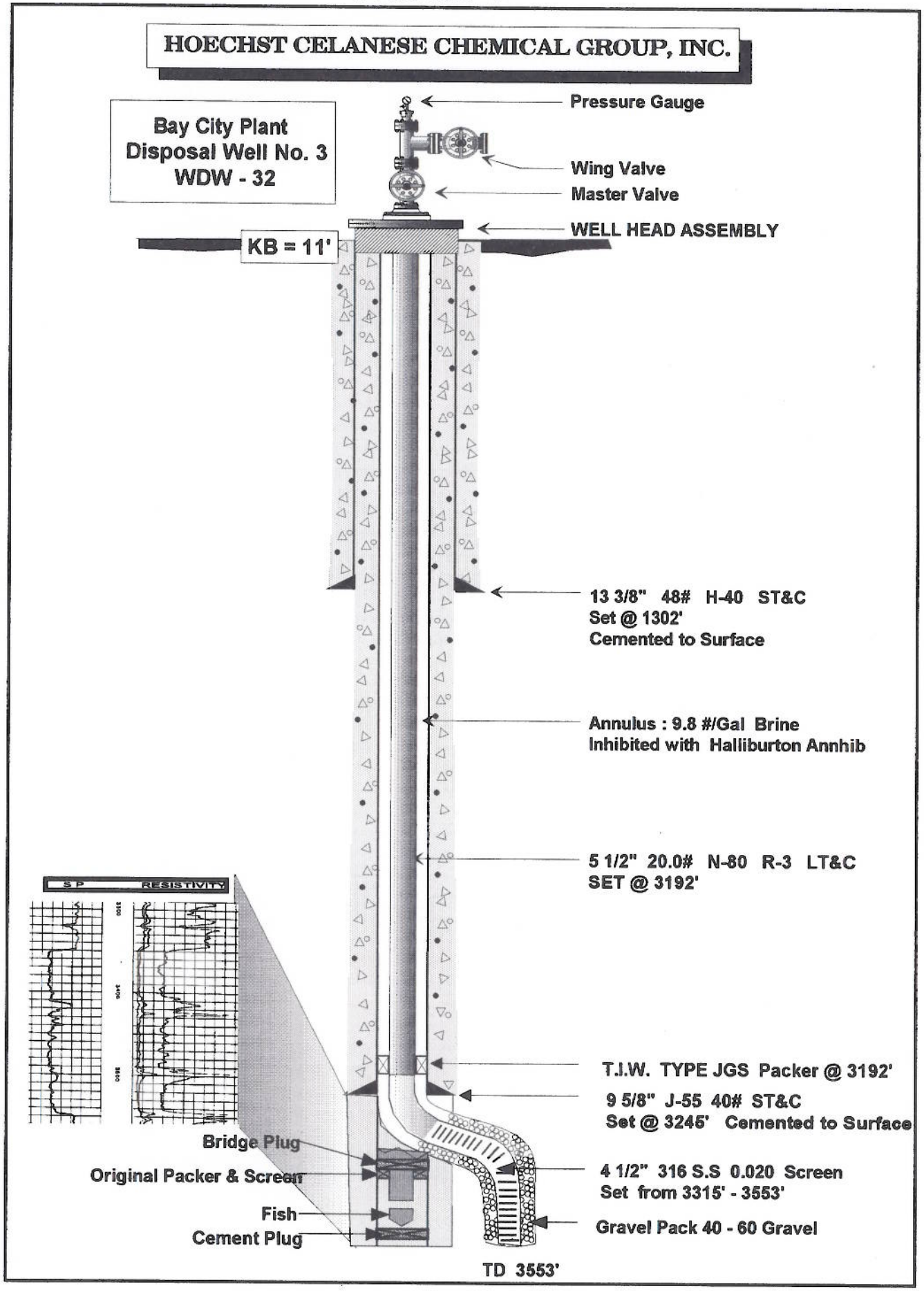
Waste stream fluid was injected into WDW-32 at a steady rate of 150 gpm for 96 hours and was shut-in for a total of 34 hours. The shape of both the pressure and pressure derivative curves on a log-log plot at early times are reasonable, but are similar to the test conducted in January 1995. A full discussion of the falloff analyses is presented in Section 4.0.

Overall Field Work Conclusion

All field work associated with the MIT/BHP/Falloff survey on HCCG's WDW-32 at the Bay City Plant conducted from October 24 through 27, 1995 was successfully completed. WDW-32 is considered to be mechanically sound at this time and is suitable for further use as a Class I waste injection well.

In accordance with the TNRCC/UIC Program, 31TAC, 331.4 and 331.43, the mechanical integrity test conducted on WDW-32 demonstrated that (1) 'there is no significant leak in the casing, tubing or packer" and (2) 'there is no significant fluid movement into an underground source of drinking water (USDW) through vertical channels adjacent to the injection borehole."

FIGURE 1


HOECHST CELANESE CHEMICAL GROUP, INC.
Bay City Plant
Disposal Well No. 3
WDW - 32
Pressure Gauge
Wing Valve
Master Valve
WELL HEAD ASSEMBLY
KB = 11'
13 3/8" 48# H-40 ST&C
Set @ 1302'
Cemented to Surface
Annulus : 9.8 #/Gal Brine
Inhibited with Halliburton Annhib
5 1/2" 20.0# N-80 R-3 LT&C
SET @ 3192'
SP
RESISTIVITY
T.I.W. TYPE JGS Packer @ 3192'
9 5/8" J-55 40# ST&C
Set @ 3245' Cemented to Surface
Bridge Plug
Original Packer & Screen
Fish
Cement Plug
4 1/2" 316 S.S 0.020 Screen
Set from 3315' - 3553'
Gravel Pack 40 - 60 Gravel
TD 3553'

2.0 FIELD OPERATIONS SUMMARY

2.1 BOTTOM HOLE PRESSURE FALLOFF SURVEY

Friday, October 20, 1995

Brought injection up to 150 gallons per minute (gpm) at 1800 hours.

Saturday, October 21 - Monday, October 23, 1995

Continued injecting at steady rate of 150 gpm.

Tuesday, October 24, 1995

Arrived at plant location at 0700, checked in with front gate. After meeting with Mr. Paul Richardson and Mr. Ray Horton, went to site of WDW-32 at 0740 hours. Effluent was being injected at well head pressure (WHP) = 610 pounds per square inch gauge (psig). At 0830 hours Mr. Ray Horton processed Wes Smith (ECO), Doug Beall and Mike Staley Milton M. Cooke Company (Cooke) through HCCG's contractor safety orientation check list. Cooke wireline rigged up on well. NOTE: All depths are referenced to rotary drive bushing (RKB) at 11' above ground level.

WDW-110 (Well No. 1-A)	out of service
WDW-14 (Well No. 2)	out of service
WDW-32 (Well No. 3)	active/injecting
WDW-49 (Well No. 4)	out of service

Checked with Paul Richardson @ control room. WDW-32 injecting approximately 150 gpm. At 0840 made run through gauge calibrations:

EPG 520 Serial # 85954 (Surface ReadOut) - Range 0 - 2500 psia.
EMS 725 Serial # 79993 (Back-up, Memory gauge)

Met with Ray Horton at 0900 hours to review test procedures and current condition of well. At 0910 hours placed tool string in lubricator (18 ft. length) as follows:

Length	Description
0.5'	Cable head
1'	Collar locator
1-1/2'	EPG 520 (SRO gauge)
4-1/2'	EPG 725 (memory gauge)
5'	weight bar
5'	weight bar

At 1045 hours opened master valve, pressured up lubricator, and prepared to go in hole. At 1056 hours check SRO gauge (WHP = 613.66 pounds per square inch absolute (psia)), going in hole. Prepare to tie into packer (RAT survey) with casing collar locator (CCL). Turned on CCL, making passes correlating strip chart. At 1200 hours tool @ 3204 ft., begin logging up hole.

Finished CCL log at 1140 hours, set gauges @ 3192 feet. Monitor injection bottom hole pressure and temperature.

At 1244 hours began monitoring injection period of test.

Injection rate	150 gpm
Down hole injection pressure	1843 psia
Surface injection pressure	610 psig

Continue monitoring injection period of test. Readings at 1600 hours:

Injection rate	150 gpm
Down hole injection pressure	1843 psia
Surface injection pressure	610 psig

Met with shift supervisor, prepared to shut-down injection operations. Stop injection pumps at 1800 hours and begin fall-off test. Double block @ injection line manifold.

Final injection conditions:	
Injection rate	150 gpm
Down hole injection pressure	1842.22 psia
Surface injection pressure	610 psig

Continue monitoring fall-off period of test at 2200 hours.

Shut-in down hole pressure	1472.16 psia
Surface	72 psig

Wednesday, October 25, 1995

Continue monitoring fall-off period of test (0800 hours).

Shut-in down hole pressure	1469.80 psia
Surface shut-in pressure	69 psig

2200 hours continue monitoring fall-off period of test.

Shut-in down hole pressure	1469 psia
Surface shut-in pressure	68 psig

Thursday, October 26, 1995

0200 hours continue monitoring fall-off period of test.

Shut-in down hole pressure	1468 psia
Surface shut-in pressure	67 psig

At 0400 hours stop recording downhole pressures, download ASCII data file, and perform preliminary analysis. Pull out of hole with tool, making static gradient stops (15 minutes/stop) at 3000', 2500', 2000', 1500', 1000', 500' and surface.

Final shut-in pressures/temperature

Shut-in down hole pressure	1468 psia
Shut-in down hole temperature	104 Deg. F
Surface shut-in pressure	67 psig

At 0700 hours gauges in lubricator and end of pressure falloff survey. Begin rigging down wireline equipment. Cooke crew leaving location at 0930 hours.

2.2 MECHANICAL INTEGRITY TEST

Thursday, October 26, 1995

At 0730 hours Wes Smith of ECO and Ray Horton of HCCG met at the front entrance to the Bay City plant and traveled to WDW-32 and met with Mr. Wilson Cupples with HCCG's instrument group. WDW-32 was shut-in with 200 psig on the tubing gauge and 67 psig on the annulus. Also, HCCG's site recorder was operational. A certified calibrated pressure instrument, Eaton Pressure Sensor, Type UPC 5000 BACB with

ranges from zero to 400, zero to 1,000 and zero to 2,000 psig, was installed onto the annulus outlet. NOTE: The zero to 2,000 psig range was utilized for this test. HCCG personnel pressurized the annulus system using nitrogen. The annulus was tested to a maximum pressure of 1109 psig. The annulus was monitored for 80 minutes. During the final 30 minute period, the pressure loss on the annulus was measured from 1102 to 1101. psig, or 1 psi (0.1%). After completion of the APT, the nitrogen gas was bled off and the annulus pressure lowered to 175 psig. WDW-32 was left shut-in.

At 1030 hours Atlas Wireline Service (Atlas) personnel arrived at HCCG's Bay City plant, checked through security and Atlas' personnel went through safety orientation. Moved in and rigged up Atlas' wireline unit including radioactive (RA) tools on WDW-32. At 1350 hours started the RAT survey as witnessed by Mr. Ray Horton of HCCG and Mr. Wes Smith of ECO. Ran tool to a maximum depth of 3250', or slightly above the disposal interval, due to damaged tubulars located immediately below this depth. Ran base gamma ray (GR) log, a short repeat section and one statistical check. Ran multiple pass survey from 3250' to 2900' with an injection rate of 50 gpm, depicting that all injected fluid was entering the lower injection interval. Repeated multiple pass survey and obtained similar positive results. Set the RAT tool at 3172' for a stationary survey, injected a RA at the same injection rate and monitored for 20 minutes with no upward flow indicated. Repeated stationary log with same results. Ran the final baseline GR log from 3250' to 2900' with no hot spots indicated. Completed the RAT survey at 1720 hours and pulled the tool out of the hole. Rigged down Atlas and moved the unit off site. WDW-32 was left shut-in. Note: Plan to brine in WDW-32 on October 27, 1995.

3.0 MECHANICAL INTEGRITY TESTING

3.1 ANNULUS PRESSURE TEST

An APT was conducted on Thursday, October 26, 1995 in order to demonstrate internal mechanical integrity. The APT was witnessed by Mr. Ray Horton of HCCG and Mr. Wesley Smith of ECO. The annulus was pressurized to a maximum pressure of 1109 psig with 67 psig on the tubing. The APT was monitored for eighty (80) minutes using a certified calibrated pressure gauge and facility recorder. During the final 30 minutes the pressure loss was measured from 1102 to 1101 psig, or 1 psi (0.1%), which was well within the 5% pressure loss criteria set by the TNRCC. An APT plot is included in Appendix B.

3.2 RADIOACTIVE TRACER SURVEY

On Thursday, October 26, 1995 a RAT survey was conducted by Atlas to insure that all fluids are entering the injection interval. Analysis of the RAT showed no upward fluid movement. Atlas and ECO conducted the RAT as follows:

1. Ran API gamma-ray (GR) tie-in strip.
2. Ran initial baseline GR log from 3250' to 2900'.
3. Ran repeat gamma-ray log from 3250' to 3000' to confirm tool repeatability.
4. Ran 5-minute statistical check at 3172'.
5. Made multiple pass survey #1 with RA slug ejected at 2900' and a pump rate of 50 gpm.
6. Made multiple pass survey #2 with a RA slug ejected at 2800' and a pump rate of 50 gpm.
7. Ran stationary survey #1 at 3172'. Watched RA slug pass tool and monitored for 20 minutes. Pump rate 50 gpm.
8. Ran stationary survey #2 at 3172'. Watched RA slug pass tool and monitored for 20 minutes. Pump rate 50 gpm.
9. Ran after survey base log from 3250' to 2900'.

3.3 ESTIMATED TIME TO RUN STATIONARY SEQUENCE

The purpose of the estimate is to calculate the "worst case" time for the radioactive slug to move from the GR tool (1) down the tubing, (2) into the screen, and (3) up the liner/casing/borehole annulus to the tool depth.

Basic Data:

Capacities:	5-1/2" tubing	-	0.9314 gal/ft.
	4-1/2" screen	-	0.653 gal/ft.
	4-1/2" screen x 12-1/4" borehole	-	5.296 gal/ft.
	9-5/8" casing x 12-1/4" borehole	-	2.343 gal/ft.
Pump Rate:	50 gpm		

Note: RAT detection tool was held stationary at 3172 feet, or 143 feet above the top of the screened liner.

Worst Case Calculations:

Volumes:	Tubing	- 20 ft. x 0.9134 gal/ft.	=	18.6
	Screen	- 123 ft. x 0.653 gal/ft.	=	80.3
	Screen/borehole	- 123 ft. x 5.296 gal/ft.	=	651.4
	Casing/borehole	- 20 ft. x 2.343 gal/ft.	=	46.9
		TOTAL		797.2 gallons

Calculated time to circulate RA slug around the end of the tubing and screen liner strings:

= 797.2 gal / 50 gpm

= 15.9 minutes

Note: Actual time surveys were run = 20 and 21 minutes

4.0 BOTTOM HOLE PRESSURE FALLOFF

Purpose Of Test: Required annual Reservoir Evaluation Test for year 1995. Calculate the following reservoir characteristics: permeability, skin damage, pressure drop due to skin and flow efficiency.

4.1 FALLOFF TEST SUMMARY OF RESULTS

Method Of Interpretation: The following analysis was performed by utilizing both Semi-Log and Log-Log analysis. **A)** The Semi-Log curve was generated by plotting the standard Horner plot, **Pressure vs** $[(t_p+\Delta t)/\Delta t]$, using an injection time (t_p) of 96 hours. The semi-log straight line was calculated by linear regression through the infinite acting flow period of the curve. The slope **m**, P_{1hr}, and **P*** values were obtained from this curve and utilized for permeability and skin calculations. **B)** The Log-Log curves were generated by plotting **ΔP** and **Pressure derivative** vs the Agarwal Equivalent time function, $[t_p\ \Delta t/(t_p+\Delta t)]$. The Log-Log curves were simultaneously positioned over Gringarten type curves until a solution match was obtained. Permeability and skin values were calculated from this match and then compared with those obtained from the Semi-Log analysis.

A. Semi-Log (Horner) The straight line area of the semi-log curve was identified by first using the 1-1/2 log cycle rule to estimate the end of wellbore storage effects. Secondly, the time of the plat portion from the Pressure Derivative curve was used in determining the area of the semi-log curve in which the straight line was drawn. The semi-log straight line yielded a slope value of **4.876 psi/cycle** and a P_{1hr} of **1475.9 psi.** The pressure difference between P_{1hr} and the injection pressure, P_{inj} of **1843.2** psi followed with the calculated slope would give indications of positive skin damage and high permeability.

B. Non-Linear Regression Using a homogeneous storage-skin-boundaries model, a non-linear regression routine was accessed to estimate the permeability, skin effect, and storage capacity that best fit the pressure data. The results of these computations are shown in the accompanying tables and are in excellent agreement with the results of the Horner plot.

C. Log-Log (Pressure and Pressure Derivative Plots) Figure 4 is a type-curve plot of the measured pressure data. Because of the high skin-effect and the high permeability of the formation, the pressure data lie above the existing type curves; consequently, type-curve analysis was not possible. However, the derivative plot shows that the middle time flow regime had been reached.

Conclusions This particular well was diagnosed to be injecting into a homogeneous reservoir with a calculated permeability of **737.5 (md)** and skin damage of **79.8** utilizing an h_{net} value of **165** feet. The flow efficiency of **19%** suggests that the near wellbore properties have a large affect on the injection volume limitations. The total pressure drop is primarily due to formation damage within a small radius from the well.

The following Table is provided to give comparative results with the previous tests and calculations. The primary variables affecting the calculated results are included.

Table 4.1

Summary of Results

Date MM/YY	Rate gpm	h_{net} ft	μ_w cp	slope psi/cycle	kh/μ	kh md-ft	k md	Skin
10/95	150	165	0.7100	4.876	171387	121685	738	+80
01/95	144	165	0.7100	3.848	208622	148122	897	+99
10/93	133	165	0.7017	4.558	163594	114789	696	+83

The calculated results indicate a difference in transmissibility, (kh/μ) of **17.8%** coupled with a **19.2%** difference in skin values between January and October 1995. In addition, the results calculated from non-linear regression analysis compare favorably to those calculated from the semi-log straight line analysis thus supporting the integrity of the calculated results. This compares to the petition transmissivity of 313,700 md-ft/cp.

The start time of the infinite acting flow period exceeded the time to exit the waste front, therefore the viscosity of the original reservoir fluid was used for the final analysis. The program used for final analysis and well simulation was "FAST", marketed by Fekete.

The formation pressures predicted by the model assume no formation damage effects or other near-bore well conditions. The measured flowing pressures corrected for skin effects and maximum predicted operational pressures are presented in the Table below:

Table 4.2

Formation Pressures

Well Name	Flowing Formation Pressures, psia	Skin Pressure Loss, psia	Revised Formation Pressure, psia	Maximum Modeled Pressure, psia
WDW-32 (Well No. 3)	1950.27 @ 3440'	338	1612	1641

The measured flowing pressure is below the maximum modeled operational pressure by more than 29 psi for WDW-32. A graph of the modeled pressures for WDW-32 is included as Appendix E. The graph shows the yearly predicted operations formation pressure (1991 through the end of 2000) using maximum modeled injection rates (250 gpm in each well). All predicted operational pressures correspond to a depth of 3440 feet below ground level and an original estimated formation pressure for the upper Miocene injection interval of 1555 psia.

The measured static formation pressures from the well tests, corrected to a depth of 3440 feet below ground level, show a formation pressure increase of 21 psi. This illustrates that injection operations at the plant have had limited impact on formation pressures and should continue to have limited impact on formation pressures in the future.

Table 4.3

Static Formation Pressure

Well	Static Formation Pressure, psia @ 3440'	Formation Pressure Increase, psia
WDW-32 (Well No. 3)	1576	+21

Table 4.4
Well Information

Well Type - INJECTION
Perforations: 3315' - 3553' (Gravel Pack Screen)

Gauge Depth 3192 feet

[Input Parameters]

Reservoir Pressure	psia	P	1469
Reservoir Temperature	Deg F	T	98
Final Static Pressure	psia	P_{si}	1469
Final Injection Pressure	psia	Pinj	1843.2
Water Flow Rate	gal/min	qw	150
Sand Thickness	feet	h_{net}	165
Wellbore Radius	feet	r_w	0.5830
Formation Porosity	%	ϕ	33.0
Extrapolated Pressure	psia	P*	1466.2
Extrapolated Press @ 1hr	psia	P_{1hr}	1475.9
Semi-Log Slope	psi/cycle	M	4.876
Production Time	hrs	t_p	96
Shut-in Time	hrs	t_{si}	34

[Fluid Properties]

Fluid Viscosity	cp	μw	7.1000E-01
Formation Volume Factor	RB/STB	βw	1.0
Fluid Compressibility	1/psi	Cw	3.0E-06
Total Compressibility	1/psi	Ct	6.0E-06

Table 4.5
Calculated Results

[Semi-Log Analysis - Horner Method]

Transmissibility	md-ft/cp	kh/u	171,387
Flow Capacity	md-ft	kh	121,685
Permeability	md	k	737.5
Skin Damage	total	S	+79.8
Pressure Drop due to Skin	psi	dP	+338
Flow Efficiency	%	FE	+19
Drainage Radius	feet	r_d	1179

FIGURE 2

HORNER
PRESSURE FALLOFF PLOT

HOECHST CELANESE
WDW-32 NO.3

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

$[k_1/u]_t$=1038.71 k_1=737.49 md s=79.8 p*=1466.2

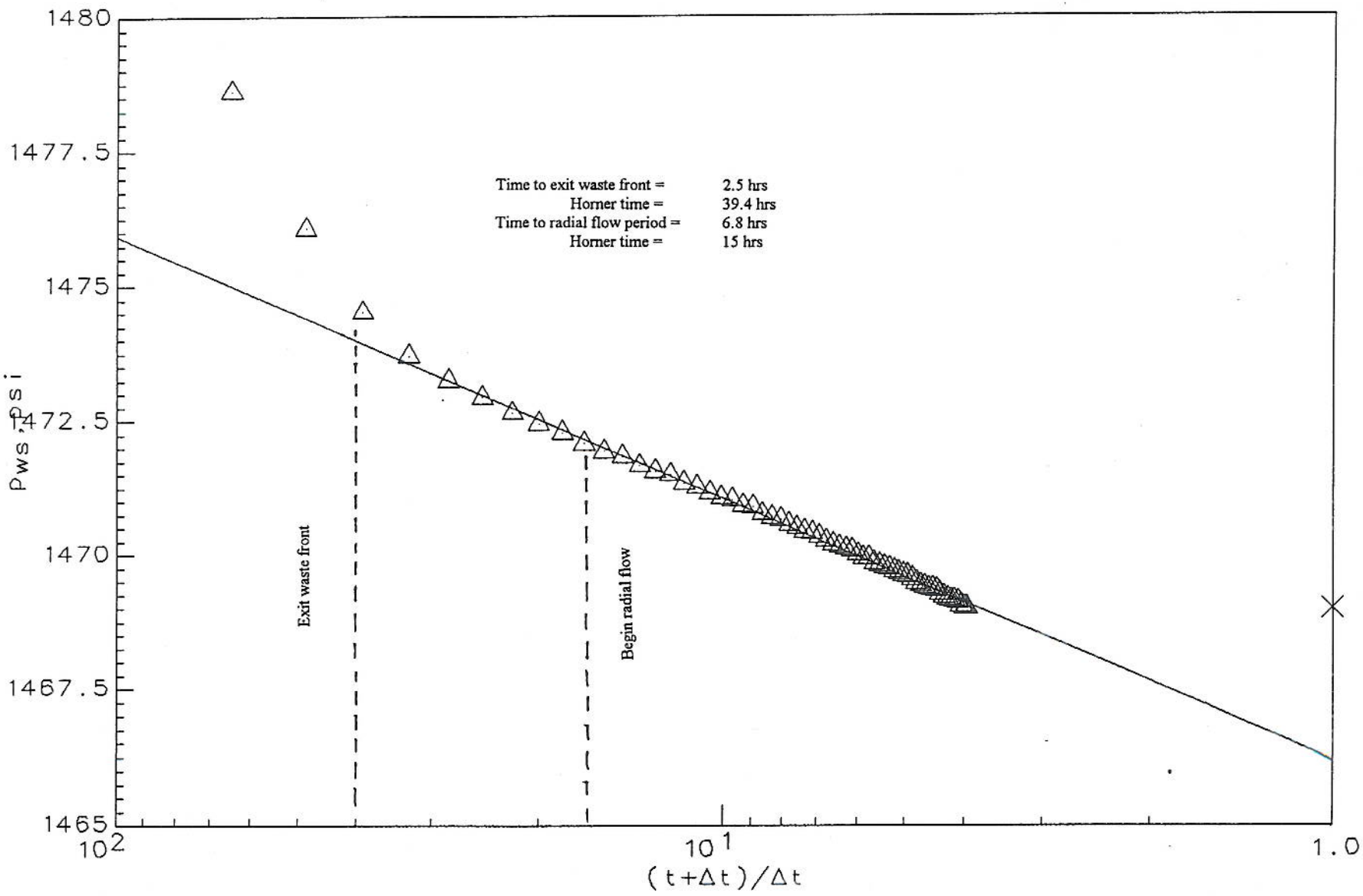


FIGURE 3

HORNER
PRESSURE FALLOFF PLOT

HOECHST CELANESE
WDW-32 NO.3

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

$[k_1/u]_t$=1038.71 k_1=737.49 md s=79.8 p*=1466.2

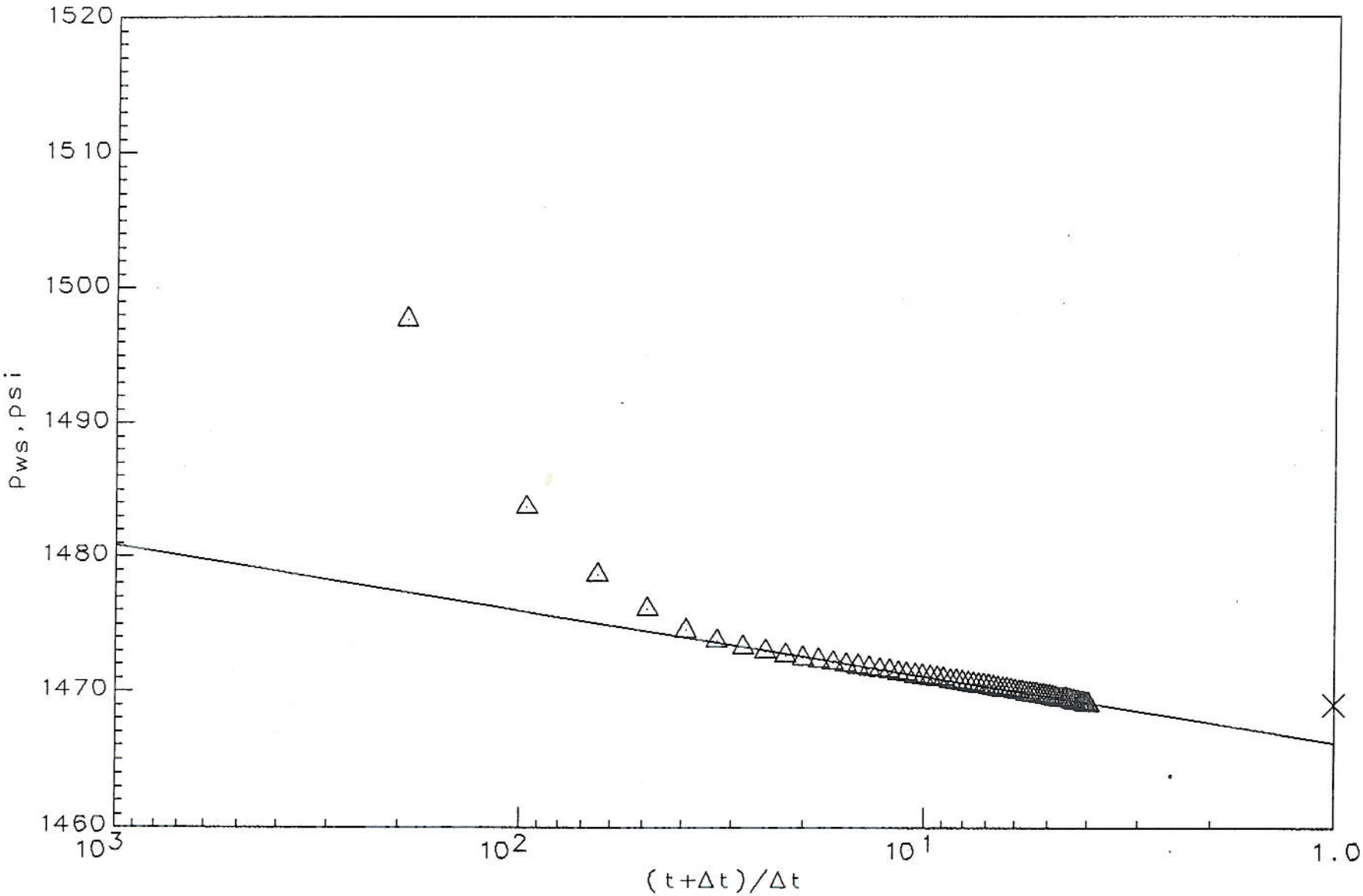


FIGURE 4

STORAGE - SKIN - BOUNDARIES

HOECHST CELANESE
WDW-32 NO.3
PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

Ave Error=0.8 psi
Synthetic p_i=1466.2 psi

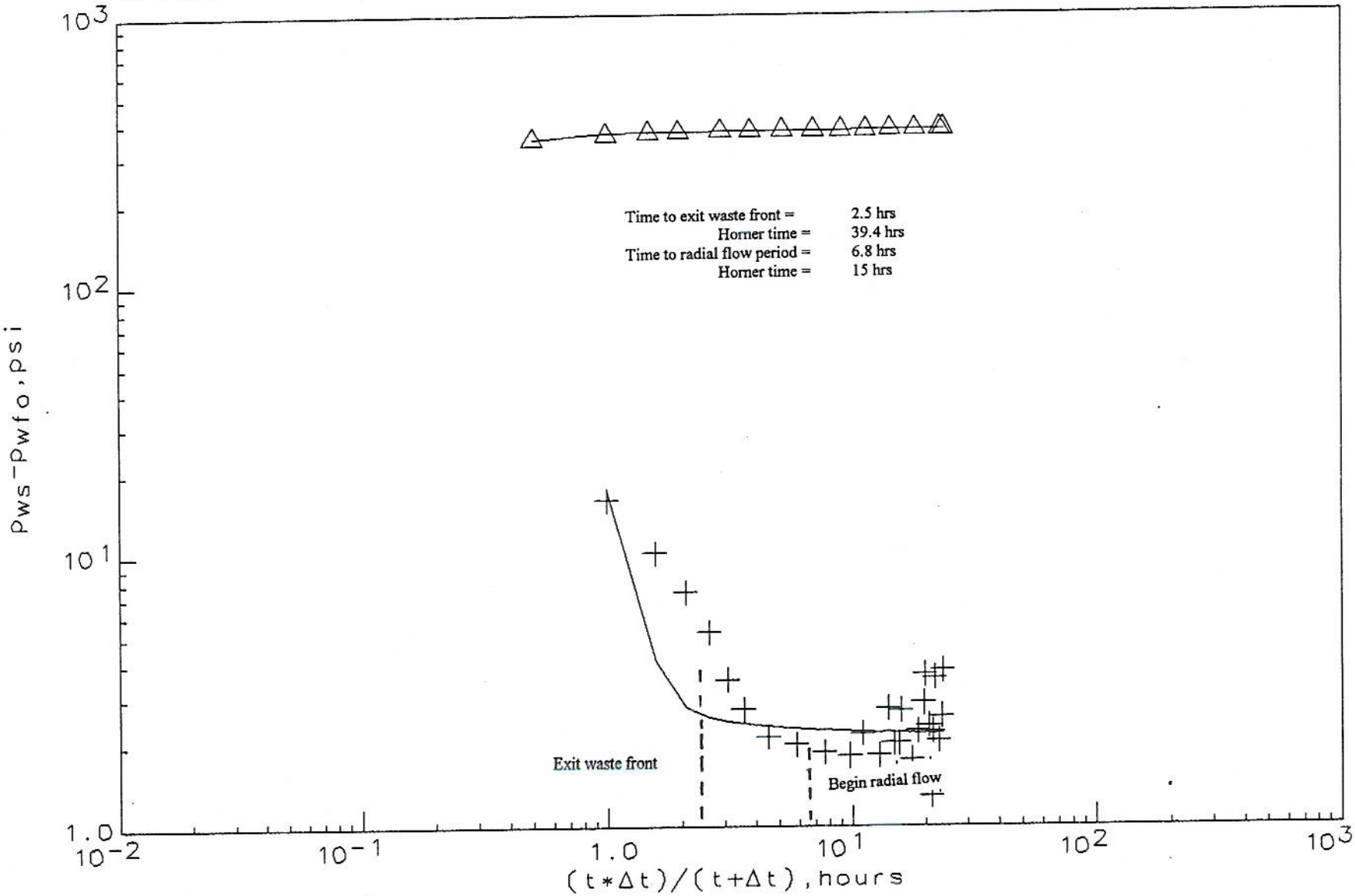


FIGURE 5

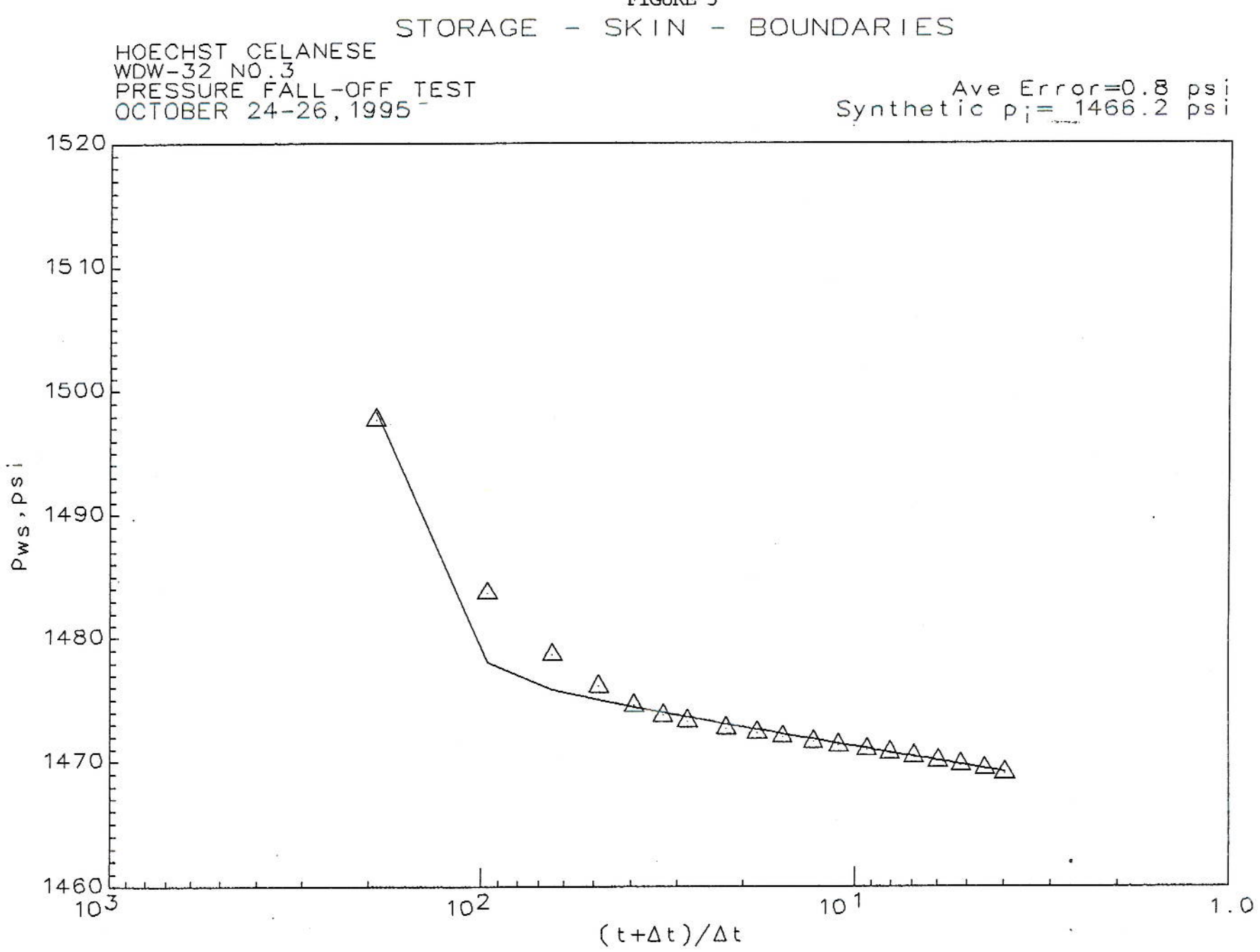

STORAGE - SKIN - BOUNDARIES
HOECHST CELANESE
WDW-32 NO.3
PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995
Ave Error=0.8 psi
Synthetic p_i= 1466.2 psi
1520
1510
1500
1490
1480
1470
1460
P_{ws}, psi
10^3
10^2
10^1
1.0
$(t+\Delta t)/\Delta t$

FIGURE 6

STORAGE AND SKIN TYPECURVE (Bourdet et al)
PRESSURE FALLOFF PLOT

HOECHST CELANESE
WDW-32 NO.3
$[k_1/u]_t$=744.09 k_1=528.30 C_D=1900 s= -

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

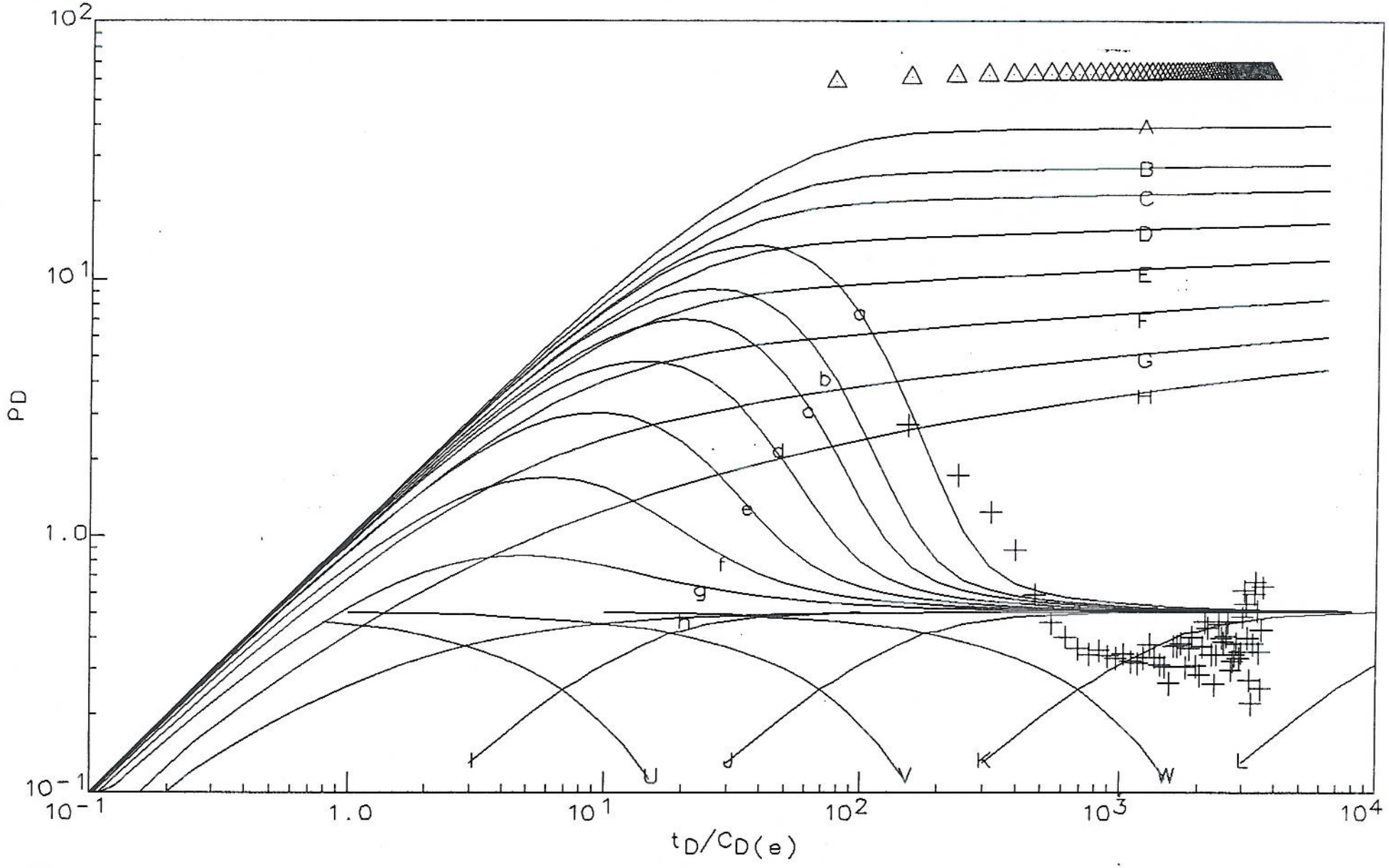


Table 4.6
FALLOFF TEST

Radial Flow Analysis

(Horner Time)

HOECHST CELANESE
WDW-32 (WELL NO. 3)

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

Reservoir Parameters

Net Pay	h =	165.00	ft	
Total Porosity	phit =	33.00	%	
Water Saturation	Sw =	0.00	%	
Wellbore Radius	r_w =	0.58	ft	
Formation Temperature	T =	98.00	deg F	
Formation Compressibility	c_f =	3.000×10^{-06}	psi^{-1}	
Total Compressibility	c_t =	6.000×10^{-06}	psi^{-1}	<DEF>

Table 4.6 (Continued)

Radial Flow Analysis

(Horner Time)

HOECHST CELANESE
WDW-32 (WELL NO. 3)

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

Zone 1

Pressures			
Initial Pressure	pi =	1469.0	psi
Extrapolated Pressure	p* =	1466.2	psi
Average Reservoir Pressure	pR =	-	psi
Final Flowing Pressure	pwfo =	1843.2	psi
Straight Line Results			
Total Sandface Rate	QTBT =	5143.00	bbl/d
Semilog Slope	msl =	4.9	psi/cycle
Transmissivity (Total)	kh/mu =	171387.54	md.ft/cp
Mobility (Total)	k/mu =	1038.712	md/cp
Flow Capacity (Oil)	kh =	121685.15	md.ft
Permeability (Oil)	k =	737.49	md
Skin Effect (Total)	s =	79.813	
Pressure Drop Due To Skin	delps =	338.2	psi
Flow Efficiency	FE =	0.19	
Damage Ratio	DR =	5.18	
Radius Of Investigation	r(inv) =	-	ft
@ Time Of Investigation	t(inv) =	-	hr

Table 4.6 (Continued)

Radial Flow Analysis

(Horner Time)

HOECHST CELANESE
WDW-32 (WELL NO. 3)

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

Zone 1

Extended Rates

3 - Month Constant Rate	=	-	bbl/d
6 - Month Constant Rate	=	-	bbl/d

Stabilized Rate

Time To Stabilize	ts =	5.038	hr
Stabilized Rate @ Current Skin	qs =	-5811.16	bbl/d
Stabilized Rate @ Skin Of 0	qs =	-65862.12	bbl/d
Stabilized Rate @ Skin Of -4	qs =	-136615.27	bbl/d

Table 4.7

Model Parameters

Storage - Skin - Boundaries Model

HOECHST CELANESE
WDW-32 (WELL NO. 3)

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

Synthetic Initial Pressure	=	1466.2	psi
Formation Parameters			
Transmissivity (Total)	kh/mu =	168683.15	md.ft/cp
Mobility (Total)	k/mu =	1022.322	md/cp
Flow Capacity	kh =	119765.03	md.ft
Permeability	k =	725.85	md
Skin	s =	78.434	
Wellbore Storage Constant (dim.)	CD =	810.75	
Inter Porosity Coeff	Lambda =	-	
Storativity Ratio	Omega =	-	
N.B. Origin At Lower Left Corner			
Reservoir Length	(xe) =	100000	ft
Reservoir Width	(ye) =	100000	ft
Active Well At	xw =	50000	ft
Active Well At	yw =	50000	ft

Table 4.8
SYNTHESIZER

Storage - Skin - Boundaries Model

HOECHST CELANESE
WDW-32 (WELL NO. 3)

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

Injection Pressure				
Final Injection Rate	qo =	-5143.00	bbl/d	
Final Flowing Pressure	Pwfo =	1843.2	psi	
Fluid Properties				
Reference Pressure	pRef =	500.0	psi	
Solution Gas Oil Ratio	Rso =	1.0	scf/bbl	
Reservoir Parameters				
Net Pay	h =	165.00	ft	
Total porosity	phit =	33.00	%	
Water Saturation	Sw =	0.00	%	
Wellbore Radius	rw =	0.58	ft	
Formation Temperature	T =	98.00	deg F	
Formation Compressibility	cf =	3.000×10^{-06}	psi^{-1}	
Total Compressibility	ct =	6.000×10^{-06}	psi^{-1}	<DEF>

Table 4.8 (Continued)
SYNTHESIZER

Storage - Skin - Boundaries Model

HOECHST CELANESE
WDW-32 (WELL NO. 3)

PRESSURE FALL-OFF TEST
OCTOBER 24-26, 1995

Synthesis Results

Average Error	=	0.8	psi
Initial Pressure	pi =	1469.0	psi
Average Reservoir Pressure	pR =	1466.2	psi
Pressure Drop Due To Skin	delps =	-	psi
Flow Efficiency	FE =	1.90	
Damage ratio	DR =	0.53	

Extended Rates

3 - Month Constant Rate	=	-5052.60	bbl/d
6 - Month Constant rate	=	-5032.69	bbl/d
1 - Year Constant Rate	=	-5008.53	bbl/d
1 - Year Constant Rate @ Skin Of 0	=	-39209.68	bbl/d
1 - Year Constant Rate @ Skin Of -4	=	-60160.14	bbl/d

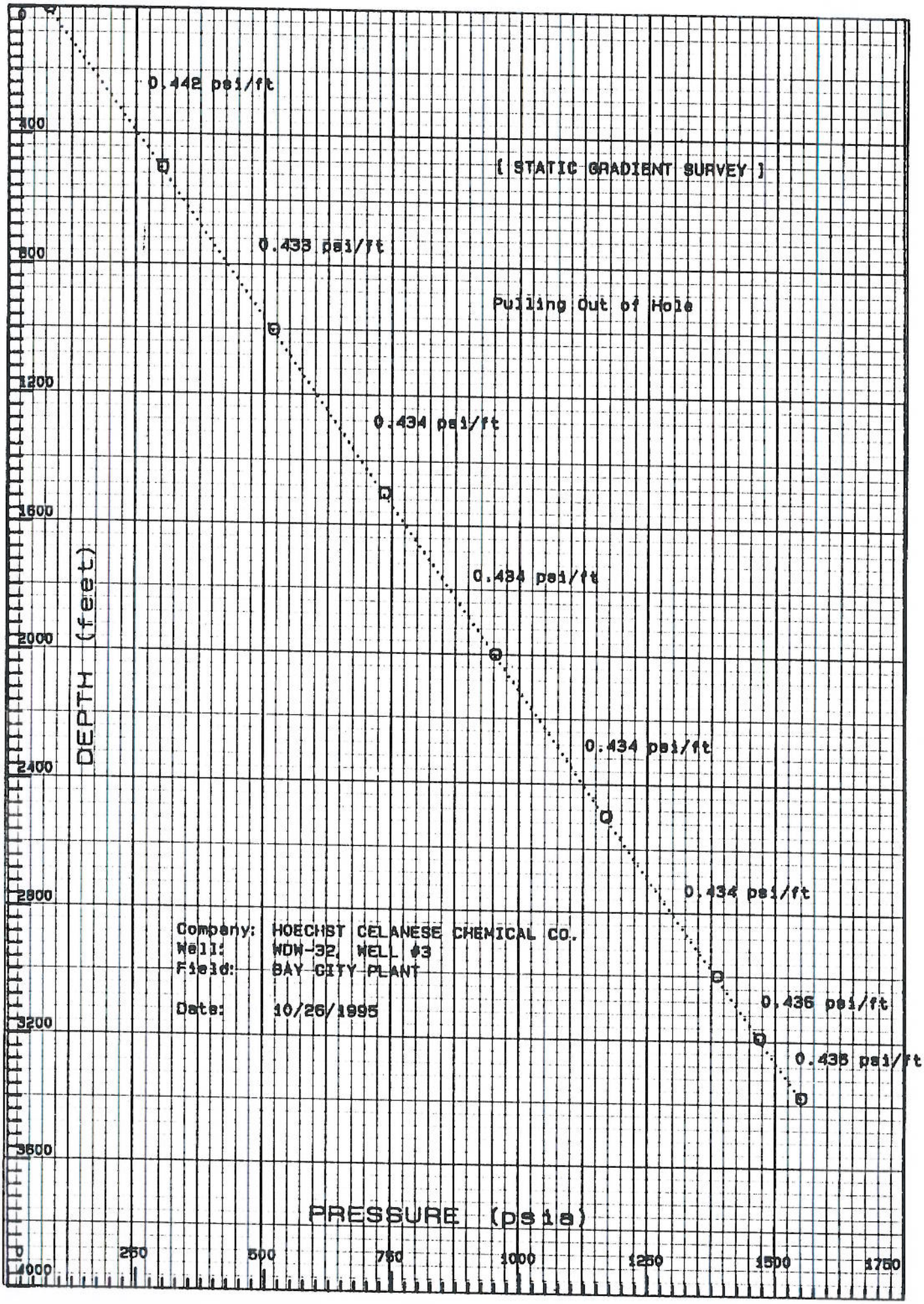
4.2 STATIC GRADIENT SURVEY

A static gradient survey was conducted while pulling out of the hole immediately following the bottom hole pressure falloff test. Stops were made at 3000', 2500', 1500', 1000', 500' and surface. Data collected during the static gradient survey is included in Appendix G and presented graphically in Figure 7. Data collected at each stop were as follows:

Table 4.9
Static Gradient Survey Results

Depth (ft)	Pressure (psia)	PSI/ft
0	78.16	
500	299.23	0.442
1000	515.91	0.433
1500	732.94	0.434
2000	950.13	0.434
2500	1167.31	0.434
3000	1384.43	0.434
3192	1468.15	0.436
3440*	1576.28	0.436

* Pressure extrapolated to mid-point perforations.


{ STATIC GRADIENT SURVEY }
Pulling Out of Hole
0.442 psi/ft
0.433 psi/ft
0.434 psi/ft
0.434 psi/ft
0.434 psi/ft
0.434 psi/ft
0.436 psi/ft
0.435 psi/ft
DEPTH (feet)
PRESSURE (psia)
Company: HOECHST CELANESE CHEMICAL CO.
Well: WDW-32, WELL #3
Field: BAY CITY PLANT
Date: 10/26/1995
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
250
500
750
1000
1250
1500
1750